CLAIMS:

1.   An active noise control apparatus for reducing noise from a noise source, comprising:

a first detector for detecting noise produced by the noise source;

a generalized finite impulse response (FIR) filter for receiving noise signals of the detected noise from said first detector, and generating control signals for reducing the noise from the noise source; and

a sound generator for producing sound based on said control signals from said generalized FIR filter for substantially canceling the noise from the noise source.

2.   The apparatus as defined in claim 1 wherein said generalized FIR filter is a feedforward compensator.

3.   The apparatus as defined in claim 2, wherein said first detector is located downstream of the noise source, and said sound generator is located downstream of said first detector.

4.   The apparatus as defined in claim 1 wherein said generalized FIR filter is described by

$$F(q,\theta)=\theta_0 + \sum_{k=1}^{N}\theta_k f_k(q), \theta = [\theta_0, \theta_1, ..., \theta_N]$$

where $f_k(q)$ are generalized (orthonormal) basis functions including information on a desired dynamic behavior of said generalized FIR filter, θ_0 is the direct feedthrough term of said generalized FIR filter and θ_k are optimal filter coefficients of said generalized FIR filter.

5.   The apparatus as defined in claim 4, wherein said generalized FIR filter is constructed by initializing said basis function $f_k(q)$, and recursively estimating said θ_k based on said initialized basis function $f_k(q)$.

6.   The apparatus as defined in claim 5, wherein said basis function $f_k(q)$ are initialized by a predetermined dynamical model that includes initial approximate information dynamics of said generalized FIR filter.

7.   The apparatus as defined in claim 5, wherein said parameters θ_k are recursively estimated by a recursive Least-Squares optimization routine.

8.   The apparatus as defined in claim 1 further comprising a second detector for detecting noise downstream of said sound generator.

9.   The apparatus as defined in claim 8, wherein a signal of the noise detected by the second detector is described by

$$e(t) = W(q)\left[H(q) + \frac{G(q)F(q)}{1 - G_c(q)F(q)} \right]n(t)$$

where, $W(q)$ is a stable and stable invertible noise filter for a white noise signal $n(t)$; $H(q)$ characterizes a dynamic relationship between the input signal $u(t)$ from said first detector and said signal $e(t)$ detected by said second detector; $G(q)$ characterizes the relationship between said control signal from said generalized FIR filter $F(q)$ and said signal $e(t)$ detected by said second detector; and $G_c(q)$ indicates an acoustic coupling from said sound generator signal back to said signal $u(t)$ from said first detector that creates a positive feedback loop with said generalized FIR filter $F(q)$.

10. The apparatus as defined in claim 9, wherein said first detector is located based on conditions at the second detector which satisfy

$$e_1(t) = H(q)u(t) \quad \text{and}$$

$$e_2(t) = -G(q)\tilde{u}(t) = -G(q)u(t) - G(q)v(t)$$

5   where $v(t)$ indicates a disturbance detected by said first detector.

11. The apparatus as defined in claim 1, wherein said first detector and said second detector are microphones, and said sound generator is a speaker.

10   12. A method for reducing noise from a noise source in an active noise control system, comprising:

detecting first noise produced by the noise source;

generating control signals from a generalized finite impulse response (FIR) filter for reducing the first noise from the noise source based on a first

15   signal of said detected noise; and

producing sound based on said control signals for substantially canceling said first noise from the noise source.

13. The method as defined in claim 12 wherein said generalized FIR

20   filter is a feedforward compensator.

14. The method as defined in claim 13, wherein said first noise is detected by a microphone located downstream of the noise source, and said sound is produced by a speaker located downstream of said microphone.

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15. The method as defined in claim 12 wherein said generalized FIR filter is described by

$$F(q,\theta) = \theta_0 + \sum_{k=1}^{N} \theta_k f_k(q), \theta = [\theta_0, \theta_1, ..., \theta_N]$$

where $f_k(q)$ are generalized (orthonormal) basis functions containing information on a desired dynamic behavior of said generalized FIR filter, θ_0 is a direct feedthrough term of said generalized FIR filter and θ_k are optimal filter coefficients of said generalized FIR filter.

16. The method as defined in claim 15, wherein said generalized FIR filter is constructed by initializing said basis function $f_k(q)$, and recursively estimating said θ_k based on said initialized basis function $f_k(q)$.

17. The method as defined in claim 16, wherein said basis function $f_k(q)$ is initialized by a predetermined dynamical model that includes initial approximate information dynamics of said generalized FIR filter.

18. The method as defined in claim 16, wherein said θ_k are recursively estimated by a recursive Least-Squares optimization routine.

19. The method as defined in claim 12 further comprising detecting second noise after said sound based on said control signals has been produced.

20. The method as defined in claim 19, wherein a second signal of the noise detected after said sound based on said control signals has been produced by the second detector is described by

$$e(t) = W(q)\left[H(q) + \frac{G(q)F(q)}{1 - G_c(q)F(q)}\right]n(t)$$

where, $W(q)$ is a stable and stable invertible noise filter for a white noise signal $n(t)$; $H(q)$ characterizes a dynamic relationship between the first signal $u(t)$ said second signal $e(t)$; $G(q)$ characterizes the relationship between said control signal from said generalized FIR filter $F(q)$ and said first signal $e(t)$; and $G_c(q)$ indicates an acoustic coupling from said sound generator signal back to said first signal $u(t)$ that creates a positive feedback loop with said generalized FIR filter $F(q)$.

21. The method as defined in claim 20, wherein said first noise is detected at a location based on conditions which satisfy

$$e_1(t) = H(q)u(t) \text{ and}$$

$$e_2(t) = -G(q)\tilde{u}(t) = -G(q)u(t) - G(q)v(t)$$

where $v(t)$ indicates a third noise detected along with said first noise.

22. An active noise control apparatus for reducing periodic noise from a noise source, comprising:

a detector for detecting noise produced by the noise source;

a controller for generating control signals for compensating the periodic noise detected in the noise; and

a sound generator for producing sound based on said control signals from said controller for substantially canceling the periodic noise from the noise source;

wherein said control signal is generated based on an equation,

$$K(q) = \arg\min_{K} \left\| \begin{array}{c} \dfrac{\alpha W_i(q)K(q)H_n(q)}{1 - G(q)W_i(q)K(q)} \\ \dfrac{W_i(q)H_n(q)}{1 - G(q)W_i(q)K(q)} \end{array} \right\|_2$$

where, $W_i(q)$ is a discrete time internal dynamical model for reducing periodic disturbances, $H_n(q)$ is a discrete time filter used to model the spectrum of the non-periodic noise disturbances, $G(q)$ is a discrete time filter that models the dynamics between sound generator and said detector and α is a scalar real-valued constant.

23.   The apparatus as defined in claim 22, wherein said controller comprises a feedback controller.

24.   The apparatus as defined in claim 22, wherein said detector is a microphone and said sound generator is a speaker, said microphone and said speaker being positioned proximate and downstream of the noise source.

25.   A method for reducing periodic noise from a noise source, comprising:

detecting noise produced by the noise source;

generating control signals from a controller for compensating the periodic noise detected in the noise; and

producing sound based on said control signals from said controller for substantially canceling the periodic noise from the noise source;

wherein said control signal is generated based on an equation,

$$K(q) = \arg\min_{K} \left\| \begin{array}{c} \dfrac{\alpha W_i(q)K(q)H_n(q)}{1 - G(q)W_i(q)K(q)} \\ \dfrac{W_i(q)H_n(q)}{1 - G(q)W_i(q)K(q)} \end{array} \right\|_2$$

where, $W_i(q)$ is a discrete time internal dynamical model for reducing periodic disturbances, $H_n(q)$ is a discrete time filter used to model a spectrum of the non-

periodic noise disturbances, G(q) is a discrete time filter that models the dynamics between a sound generator for producing said sound based on said control signals and a detector for detecting the noise produced by the noise source, and α is a scalar real-valued constant.

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26.   The method as defined in claim 25, wherein said controller comprises a feedback controller.

27.   The method as defined in claim 25, wherein the noise is detected by 10   a microphone and said sound based on said control signals from said controller is produced by a speaker, said microphone and said speaker being positioned proximate and downstream of the noise source.